International Journal of Computational and Experimental Science and ENgineering (IJCESEN)

Vol. 11-No.3 (2025) pp. 5599-5605
http://www.ijcesen.com

ISSN: 2149-9144

Research Article

First experimental survey of *Chlamydia abortus* in the genital tract of cows slaughtered in Algeria

Radja Zineddine[1, 2, *], Djamila Hezil [3], Hassane Benseghir[4], Mutien Garigliany[5], Farida Ghalmi[6]

[1] Department of Veterinary Sciences, Faculty of Natural and Life Sciences and Earth and Universe Sciences, Mohamed Khider University, 07000 Biskra, Algeria.
[2] Research Laboratory Management of Local Animal Resources Higher National Veterinary School, Elalia, Oued Smar, 1615, Algeirs, Algeria.
***Corresponding Author Email:** radja.zineddine@univ-biskra.dz -**ORCID:** 0000-0002-1416-8272

[3] Department of Biology, Faculty of Sciences, M'Hamed Bougara University, Boumerdes 035000, Algeria.
Email: hezildjamila@yahoo.fr-**ORCID:** 0000-0002-7764-0087

[4] Department of Microbiology and Biochemistry, Faculty of Natural and Life Sciences, University of Batna2 05078, Algeria.
Email: h.benseghir@univ-batna2.dz-**ORCID:** 0000-0001-7219-3321

[5] Department of Pathology, Faculty of Veterinary Medicine, Centre for Fundamental and Applied Research for Animals & Health (FARAH), Liège Université, B-4000 Liège, Belgium.
Email: mmgarigliany@ulg.ac.be -**ORCID:** 0000-0003-0026-2468

[6] Research Laboratory Management of Local Animal Resources Higher National Veterinary School, Elalia, Oued Smar, 1615, Algeirs, Algeria.
Email: ghalmifa@yahoo.fr -**ORCID:** 0000-0001-6096-5726

Article Info:

DOI: 10.22399/ijcesen.3461
Received : 12 April 2025
Accepted : 20 July 2025

Keywords

Abnormalities
Chlamydia abortus
Genital tract
Tissue samples
reel-time PCR

Abstract:

The analysis of samples from the genital tract of slaughtered cattle allows for the assessment of the impact of infections on reproduction. Among the agents involved, Chlamydiaceae are known for their role in these diseases. The objective of this study was to investigate the presence of *Chlamydia abortus* in the reproductive tract of cull cows and to explore the potential correlation between the presence of apparent morphological lesions in the genital tract and the carriage of the bacteria. Macroscopic examination of 405 female bovine genital tracts collected from abattoirs in eastern Algeria revealed a 7.16% prevalence of apparent morphological abnormalities, with ovarian lesions predominating. Real-time PCR analysis of tissue samples taken from the genital tract of cows aimed at detecting the DNA of *Chlamydia abortus* targeting a fragment of the ompA gene, revealed no trace of the bacterium in the tissue samples analysed. The results suggest the occasional presence of the bacterium in the genital tract of female cattle and call into question the hypothesis that cows act as a reservoir for *Chlamydia abortus*.

1. Introduction

Diseases and abnormalities of the genital tract in cattle are considered the main cause of economic losses related to sterility and infertility, leading to the culling of cows [1]. To minimize these economic losses in cattle farming, it is plays a central role in identifying these problems [2]. Thus, the analysis of essential to determine the incidence of various genital pathologies. Since most reproductive issues in cattle do not have remarkable external manifestations, the examination of macroscopic and microscopic lesions of the reproductive tract. samples from slaughterhouses provides valuable information on the incidence of reproductive disorders [3]. The infectious agents responsible for reproductive disorders in cattle are numerous [4]. The immune and inflammatory responses against these microorganisms contribute both to the elimination of the infection and to the pathology in the host's tissues. However, inappropriate responses can occur, leading to excessive inflammatory reactions, delayed wound healing, and more severe tissue damage [5].

The role of Chlamydia in reproductive diseases of cows has been widely studied, but it is unclear whether these organisms are pathogenic or commensal [6]. Nevertheless, there is suspicion of a potential impact of subclinical infections on the health and fertility of the cattle herd [7, 8].

Chlamydia abortus, a Gram-negative bacterium belonging to the Chlamydiaceae family, is an obligate intracellular organism distributed worldwide. It is primarily [9] associated with reproductive disorders in female cattle, such as abortion, fetal death, infertility, chronic mastitis, endometritis, and salpingitis [10,11].

Because of this microorganism's zoonotic origin and veterinary significance, interest in it has grown [12]. In fact, cattle act as reservoirs since they frequently carry the disease asymptomatically,endangering people and other domestic ruminant species [13]. It is essential to investigate the possible harmful consequences of these organisms on animal health and productivity because subclinical Chlamydia infections in cattle are so common.

This study aimed to assess the presence of *Chlamydia abortus* in the reproductive tract of cull cows from eastern Algerian slaughterhouses and investigate whether there is a relationship between the bacterium's carriage and the presence of apparent morphological lesions in the reproductive trac.

2. Material and Methods

2.1. Study area

Our study was carried out in the north-eastern region of Algeria. The study focused on seven municipal abattoirs located in five wilayas in eastern Algeria: Jijel, Constantine, Oum El Bouaghi, Setif and Bourdj Bou Arreridj.

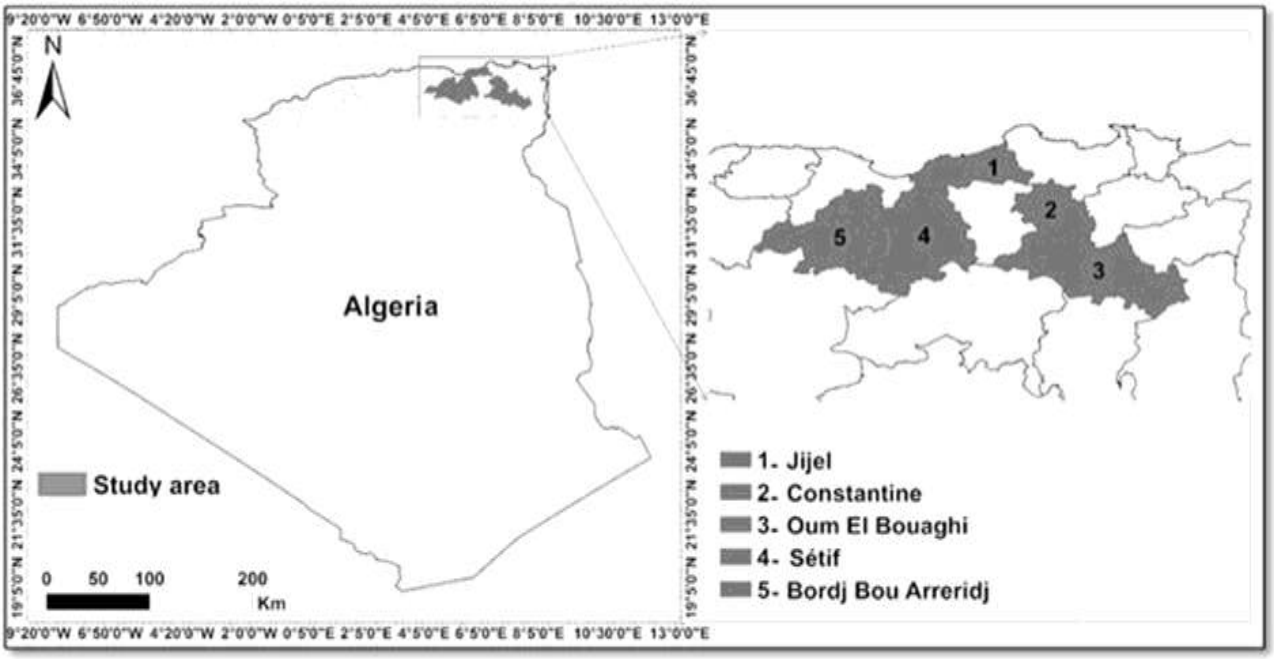

Figure 1: *Map of the study area showing the north-eastern Algerian states covered by our study.*

2.2. Study design and sampling

This study was designed to investigate the presence of the organism *Chlamydia abortus* in slaughtered cows by molecular detection of the bacterium's DNA in genital matrices. A total of 405 genital matrices from culled dairy cows from different regions were collected after slaughter **(Table. 1)**. For each animal, an information sheet was completed in collaboration with slaughterhouse employees, including information such as the animal's ID, approximate age and carcass condition.In the laboratory, macroscopic observation of the organs was carried out before and after sectioning to detect possible pregnancy and any macroscopically visible abnormalities (inflammation, fibrosis, necrosis, cysts or others). Tissue samples were taken at random from various parts of the reproductive tract, including the oviducts, endometrium, internal cervix and lesions if present under conditions of total asepsis.

The various tissue fragments were collected in pre-identified sterile tubes and stored at -20°C before being transported to the Centre for Fundamental and Applied Animal Research (FARAH) at the University of Liège in Belgium for PCR testing.

2.3. Molecular analysis

Detection of *Chlamydia abortus* nucleic acid was carried out using a pool testing strategy. After real-time PCR analysis, positive pools were re-analysed to identify the exact sample that carried the pathogen's DNA.

DNA extraction

Prior to DNA extraction, tissue lysis was performed. Each tissue sample was placed in a tube containing 500 µL of sterile phosphate buffer solution (PBS) and a stainless steel magnetic ball supplied by Qiagen. The tubes were then transferred to the Tissue Lyser II. (Qiagen, Venlo, The Netherlands), where the tissue fragments were lysed for 3 minutes at a frequency of 30.0 oscillations per second. The tubes were then centrifuged for 3 minutes at 13,000 rotations per minute. The supernatant was collected and pools of four samples were randomly formed, each pool containing 75 µL of each sample to give a final volume of 300 µL.

DNA was extracted from each pool by adding 10 µL of Proteinase K to the previously prepared 300 µL volume, using the TANBead® Nucleic Acid Extraction kit in a fully automated process. The extracted DNA was stored at -20°C under sterile conditions until further use. After qPCR analysis, the positive pools were extracted individually by adding 10 µL of Proteinase K to the 300 µL volume of each sample.

Real-time PCR

Tissue DNA was pooled and tested by real-time PCR. This analysis targeted an 82 base pair (bp) fragment of the outer membrane protein A (OmpA) gene using a Luna® Universal Probe qPCR Master Mix kit (Bioké) following the protocol described by Pantchev and colleagues [14] and using the endogenous amplification control of the beta-actin gene. The probe used to detect beta-actin is linked to hexachloro-fluorescein (HEX) **(Table 2)**.

Table 2. *Primers and probe used for detection of Chlamydia abortus DNA by qPCR*

Primer or probe	Sequence	Size
OmpA-F	5'-GCA ACT GAC ACT AAG TCG GCT ACA-3'	82 pb
OmpA-R	5'-ACA AGC ATG TTC AAT CGA TAA GAG A-3'	
OmpA-P	5'-/56-FAM/TAA ATA CCA/ZEN/CGA ATG GCA-3'	

Real-time PCR was performed on the QuantStudio™ 1 Real-Time PCR System with a final volume of 15 µL of reaction mixture **(Table. 3)**. Amplification conditions included a 5-minute denaturation step at 95°C, followed by 45 thermocycles consisting of 10 seconds at 95°C, 20 seconds at 50°C and 20 seconds at 72°C.

Table 3. *Composition of the reaction mixture for real-time PCR analysis*

Constituent	Volume
Master Mix Luna qPCR Probe (Bioké)	7,5 µL
Eau UP	4 µL
Mix amorce (20µl F + 20 µL R + 10µL P)	1,5 µL
ADN	2 µL
Total volume	**15 µL**

F: forward primer; R: reverse primer; P: probe

After individual extraction of the positive pools, each sample DNA was tested by real-time PCR to determine the positive sample(s).

3. Results and Discussions

3.1. Morphological examination of the genital tract

Gestational status

In the present study, of the 405 uteri examined, 31 were pregnant (7.65%), including 22 in the first trimester of gestation and 9 in the second trimester. The genital tracts of the pregnant matrices observed showed no apparent morphological abnormalities.

Abnormalities of the genital tract

Of the 405 genital tracts autopsied, 29 showed at least one macroscopic lesion, corresponding to a prevalence of 7.16%. Of these cases, only one tract had two abnormalities simultaneously (Metritis and ovarian cyst).

The most frequent lesions were those of the ovaries, with 16 cases observed, all localised to a single ovary. Lesions affecting the uterus were present in 9 of the matrices examined, while those affecting the oviducts were reported in 5 tracts, also localised to a single side. In addition, lesions affecting the cervix were not reported in any tract. Table 4 summarises the results obtained.least one macroscopic lesion, corresponding to a prevalence of 7.16%. Of these cases, only one tract had two abnormalities simultaneously (Metritis and ovarian cyst).

The most frequent lesions were those of the ovaries, with 16 cases observed, all localisesingle ovary. Lesions affecting the uterus were present in 9 of the matrices examined, while those affecting the oviducts were reported in 5 tracts, also localised to a single side. In addition, lesions affecting the cervix were not reported in any tract **(Table 4).**

Table4. *Distribution of genital tract according to lesions revealed by macroscopic examination*

Site of lesion	Type of lesion	Number of cases		Percentage
Ovaries	Ovarian cyst	15	16	55%
	Paraovarian cyst	1		
Uterus	Purulent metritis	2	9	31%
	Non-purulent metritis	6		
	Necrosis	1		
Oviduct	Inflammation	2	4	14%
	Fibrosis	2		

Examination of the 405 carcasses revealed no visible lesions. The slaughterhouse veterinarians confirmed that no carcasses or viscera from the cows slaughtered in our study had been totally or partially seized. The age of the cows slaughtered was classified into three groups: under 5 years, between 5 and 10 years and over 10 years. Cows less than 5 years old accounted for 8.14% (n=33), those between 5 and 10 years old 46.17% (n=187) and those over 10 years old 45.67% (n=185). **Table 5** shows the distribution of lesions by age group.

Table 5. *Distribution of genital tract lesions by age of cows slaughtered*

Age (Years)	Site of Lesion	Type of Lesion	Number		Prévalence(%)
<5	Ovaries	Ovarian Cyst	7	33	21.21
		Paraovarian Cyst	0		0
	Oviducts	Inflammation	0		0
		Fibrosis	0		0
	Utérus	Purulent Metritis	2		6.06
		Non-purulent Metritis	4		12.12
		Nécrosis	0		0
5-10	Ovaries	Ovarian Cyst	7	187	3.74
		Paraovarian Cyst	1		0.53
	Oviducts	Inflammation	2		1.06
		Fibrosis	1		0.53
	Utérus	Purulent Metritis	0		0
		Non-purulent Metritis	2		1.06
		Nécrosis	0		0
>10	Ovaires	Ovarian Cyst	1	185	0.54
		Paraovarian Cyst	0		0
	Oviductes	Inflammation	0		0
		Fibrosis	0		0
	Utérus	Purulent Metritis	0		0
		Non-purulent Metritis	0		0
		Nécrosis	1		0.54

3.2. Prevalence of *Chlamydia abortus*

A ß-actin signal was detected in all pools and samples tested by real-time PCR, indicating the absence of signs of extraction failure or inhibition.Real-time PCR analysis revealed the absence of *Chlamydia abortus* DNA in the pools tested. The analysis was performed on each sample individually and revealed a prevalence of 0 in the 405 tissue samples tested.

Discussion

Reproductive diseases are one of the main causes of culling in dairy herds [15], representing a major problem for farmers and a considerable economic loss for the national and global economy.In this study, in which we examined 405 genital tracts of culled cows, 31 matrices (7.65%) were pregnant, 22 in the first trimester of gestation and 9 in the second trimester.In this study, we examined 405 genital tracts of culled cows. Of these, 31 matrices (7.65%) were pregnant, 22 in the first trimester of gestation and 9 in the second trimester. The slaughter of pregnant cattle is counterproductive, detrimental to food safety and raises ethical controversies. A 2016 study by Mimoune and colleagues found that 16.46% of cows slaughtered at an abattoir in Algiers were pregnant [16]. This incidence is higher than that observed in our study.Numerous studies around the world have reported varying rates of slaughter of pregnant cattle. In Denmark, for example, 23% of cows slaughtered were pregnant: 16% in the first third of pregnancy, 5% in the second third and 0.4% in the third third [17]. In Nigeria, Njoga and colleagues reported in 2021 an incidence of 17.4%, with 43.2% of fetuses recovered in the third trimester [18].Of the 405 genital tracts examined, 29 (7.16%) had at least one macroscopic abnormality: 16 abnormalities located in the ovaries, 9 in the uterus and 5 in the oviducts. Ovarian anomalies were more frequent in cows under 5 years of age, as were uterine anomalies. Cows over 10 years of age were the least affected by macroscopic lesions. Of the 16 ovarian anomalies, cysts predominated (15/16), with a single case of paraovarian cyst observed in a cow aged over 5 years. Uterine anomalies (9 cases) were more frequent in cows under 5 years of age (6/9), dominated by non-purulent metritis. Oviductal lesions were the least frequent (4 cases out of 29).The data available in the literature show a heterogeneous rate of reproductive tract abnormalities in culled cows. In Algeria, Mimoune et al. reported an incidence of 53.28%, significantly higher than that observed in our study, with a predominance of ovarian lesions (14.78%) [16]. However, in another study carried out in Jijel, the same authors reported a prevalence of 19.04%, with uterine lesions predominating (8.70%) [3].Internationally, studies also indicate a predominance of ovarian lesions. For example, the overall prevalences reported are 20% in the UK [19], 35.9% in Ethiopia [2], 13.13% in Yemen [20] and 6% in Turkey for ovarian and oviductal anomalies [21].Real-time PCR analysis of the 405 genital tracts revealed no traces of *Chlamydia abortus* DNA. None of the genital tracts studied were found to contain the bacterium.Several studies have demonstrated the presence of *Chlamydiaceae* in the genital tract of different species, including humans and animals. For example, in 1992, *Chlamydia trachomatis* was isolated from 30.9% of infertile women undergoing laparoscopy [22]. In cats, experimental inoculation of the uterine tubes with *Chlamydia psittaci* caused inflammatory disease [23]. In breeding pigs, chlamydial infections have been observed in the uterus and oviduct, with no correlation with apparent lesions [24]. In mares, chronic endometrial lesions have been associated with the presence of *Chlamydia abortus* in the uterus [25].The role of *Chlamydia abortus*, the agent of bovine epizootic abortion, in reproductive disorders has been confirmed by several studies [7, 26]. However, detection methods based on molecular biology have revealed that these infections may be subclinical, raising the question of the pathogenic or commensal status of these bacteria [6]. Some research has attributed to *Chlamydia abortus* infections causing lesions such as metritis and salpingitis, which can lead to infertility [27, 28, 29]. Other studies suggest a commensal role, as no visible histopathological changes have been observed in some cases [30, 31].

4. Conclusion

The macroscopic examination of 405 bovine genital tracts collected from slaughterhouses in eastern Algeria revealed a prevalence of 7.16% at least one macroscopic anomaly. The qPCR analysis aimed at detecting the DNA of *Chlamydia abortus* found no trace of the bacterium in any of the analyzed tissue samples. This leads us to dismiss the theory of commensalism of the bacterium in female cattle and suggests a rather occasional presence instead. The presumed role of cows as a reservoir for *Chlamydia abortus* appears to be negligible.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

- **Acknowledgments:**The authors would like to thank all those who contributed to the production of this work.

- **Author contributions:** The authors declare that they have equal right on this paper.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

[1] Koreyba, L. V. (2023). Major diseases of pregnancy and abortion in cows. Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Veterinary Sciences, 25(112), 62-66. https://doi.org/10.32718/nvlvet11210

[2] Mekibib, B., Desta, T., & Tesfaye, D. (2013). Gross pathological changes in the reproductive tracts of cows slaughtered at two abattoirs in Southern Ethiopia. Journal of Veterinary Medicine and Animal Health, 5(2), 46-50. https://doi.org/10.5897/JVMAH12.060

[3] Mimoune, N., Hamiroune, M., Boukhechem, S., Mecherouk, C., Harhoura, K., Khelef, D., & Kaidi, R. (2022). Pathological Findings in Cattle Slaughtered in Northeastern Algeria and Associated Risk Factors. Veterinary Sciences, 9(7), 330. https://doi.org/10.3390/vetsci9070330.

[4] Carneiro, L. C., Cronin, J. G., & Sheldon, I. M. (2016). Mechanisms linking bacterial infections of the bovine endometrium to disease and infertility. Reproductive biology, 16(1), 1-7. https://doi.org/10.1016/j.repbio.2015.12.002

[5] Xiang, W., Yu, N., Lei, A., Li, X., Tan, S., Huang, L., & Zhou, Z. (2021). Insights into host cell cytokines in Chlamydia infection. Front. Immunol. 12:639834. https://doi.org/10.3389/fimmu.2021.639834

[6] Reinhold P, Sachse K, Kaltenboeck B. (2011). Chlamydiaceae in cattle: commensals, trigger organisms, or pathogens? Vet J 189, 257–267. https://doi.org/10.1016/j.tvjl.2010.09.003

[7] Kaltenboeck B., Hehnen HR., Vaglenov A. (2005). Bovine Chlamydophila spp. infection: do we underestimate the impact on fertility? Vet Res Commun 29(Suppl. 1), 1–15. https://doi.org/10.1007/s11259-005-0832-4

[8] Owhor, L. E., Reese, S., & Kölle, S. (2019). Salpingitis impairs bovine tubal function and sperm-oviduct interaction. Scientific reports, 9(1), 10893. https://doi.org/10.1038/s41598-019-47431-x

[9] Borel, N., Polkinghorne, A., & Pospischil, A. (2018). A review on chlamydial diseases in animals: still a challenge for pathologists?. Veterinary pathology, 55(3), 374-390. https://doi.org/10.1177/0300985817751218

[10] Longbottom D., Coulter L.J. (2003). Animal chlamydioses and zoonotic implications. Comp J. Path, 128, 217-244. https://doi.org/10.1053/jcpa.2002.0629

[11] Degraves F-J. Kim T. Jee J. Schlapp T. Hehnen H. R. Et Kaltenboeck B. (2004). Reinfection with Chlamydophila abortus by uterine and indirect cohort routes reduces fertility in cattle preexposed to Chlamydophila. Infection and immunity, 72, 2538-2545. https://doi.org/10.1128/iai.72.5.2538

[12] Turin, L., Surini, S., Wheelhouse, N., & Rocchi, M. S. (2022). Recent advances and public health implications for environmental exposure to *Chlamydia abortus*: from enzootic to zoonotic disease. Veterinary research, 53(1), 37.https://doi.org/10.1186/s13567-022-01052-x

[13] Li, Z., Liu, P., Cao, X., Lou, Z., Zaręba-Marchewka, K., Szymańska-Czerwińska, M., ... & Zhou, J. (2018). First report of *Chlamydia abortus* in farmed fur animals. BioMed research international, 2018(1), 4289648. https://doi.org/10.1155/2018/4289648

[14] Pantchev, A., Sting, R., Bauerfeind, R., Tyczka, J., & Sachse, K. (2009). New real-time PCR tests for species-specific detection of *Chlamydophila psittaci* and *Chlamydophila abortus* from tissue samples. The Veterinary Journal, 181(2), 145-150. https://doi.org/10.1016/j.tvjl.2008.02.025

[15] Godin A.C., björkman, C., Englund, S., Johansson, K. E., Niskanen, R., Alenius, S. (2008). Investigation of Chlamydophila spp. in dairy cows with reproductive disorders. Acta Veterinaria Scandinavica, 50, 1-6. https://doi.org/10.1186/1751-0147-50-39

[16] Mimoune, N., Kaidi, R., MY, A., Keddour, R., Belarbi, A., & SY, D. (2016). Genital tract pathologies of cows slaughtered at El-Harrach abattoir in Algeria. Kafkas üniversitesi veteriner fakültesi dergisi, 22(5). https://doi.org/10.9775/kvfd.2015.14737

[17] Nielsen, SS, Sandøe, P., Kjølsted, SU et Agerholm, JS. (2019). Abattage de bovins gestants au Danemark: prévalence, âge gestationnel et raisons. Animaux , 9 (7), 392. https://doi.org/10.3390/ani9070392.

[18] Njoga, U. J., Njoga, E. O., Nwobi, O. C., Abonyi, F. O., Edeh, H. O., Ajibo, F. E., ... & Guiné, R. P. (2021). Slaughter conditions and slaughtering of pregnant cows in southeast Nigeria: Implications to meat quality, food safety and security. Foods, 10(6), 1298. https://doi.org/10.3390/foods10061298

[19] Millward, S., Mueller, K., Smith, R., & Higgins, H. M. (2019). A post-mortem survey of bovine female reproductive tracts in the UK. Frontiers in

veterinary science, 6, 451. https://doi.org/10.3389/fvets.2019.00451
[20] Mohammad, A. G. (2013). Pathological abnormalities in genital tract of cows slaughtered at Dhamar abattoirs, Yemen. Yemeni Journal of Agriculture & Veterinary Sciences, 1(1). https://doi.org/10.70022/yjavs.v1i1.10
[21] Hatipoglu, F., Kiran, M. M., Ortatatli, M., Erer, H., & Çiftçi, M. K. (2002). An abattoir study of genital pathology in cows: I. Ovary and oviduct. Revue de médecine vétérinaire, 153(1), 29-34.
[22] Lucisano, A., Morandotti, G., Marana, R., Leone, F., Branca, G., Dell'Acqua, S., & Sanna, A. (1992). Chlamidial genital infections and laparoscopic findings in infertile women. European journal of epidemiology, 8, 645-649. https://doi.org/10.1007/BF00145378
[23] Kane, J. L., Woodland, R. M., Elder, M. G., & Darougar, S. (1985). Chlamydial pelvic infection in cats: a model for the study of human pelvic inflammatory disease. Sexually Transmitted Infections, 61(5), 311-318. https://doi.org/10.1136/sti.61.5.311
[24] Kauffold J, Melzer F, Berndt A, Hoffmann G, Hotzel H, Sachse K. (2006). Chlamydiae in oviducts and uteri of repeat breeder pigs. Theriogenology 66, 1816–1823. https://doi.org/10.1016/j.theriogenology.2006.04.042
[25] Nervo, T., Nebbia, P., Bertero, A., Robino, P., Stella, M. C., Rota, A., & Appino, S. (2019). Chronic endometritis in subfertile mares with presence of Chlamydial DNA. Journal of Equine Veterinary Science, 73, 91-94. https://doi.org/10.1016/j.jevs.2018.12.003
[26] Wang, F.-I., Shieh, H., Liao, Y.-K. (2001). Prevalence of *Chlamydophila abortus* infection in domesticated ruminants in Taiwan. Journal of Veterinary Medical Science 63, 1215–1220. https://doi.org/10.1292/jvms.63.1215
[27] Wittenbrink MM, Schoon HA, Bisping W, Binder A. (1993): Infection of the bovine female genital tract with *Chlamydia psittaci* as a possible cause of infertility. Reprod Dom Anim 28, 129-136. https://doi.org/10.1111/j.1439-0450.1993.tb00161.x
[28] Appino S., Pregel P., Manuali E., Vincenti L., Rota A., Carnieletto P., Tiberi C., Bollo E. (2007). Infection of bovine cell cultures with *Chlamydophila abortus*. Anim Reprod Sci 98, 350–356. https://doi.org/10.1016/j.anireprosci.2006.03.006
[29] Dobos, A., Fodor, I., Kreizinger, Z., Makrai, L., Dénes, B., Kiss, I., ... Szeredi, L. (2022). Infertilité chez les vaches laitières - Causes bactériennes et virales possibles. Veterinarska stanica, 53 (1), 35-43. https://doi.org/10.46419/vs.53.1.8.
[30] Bowen RA., Spears P., Storz J., Seidel GE. (1978). Mechanisms of infertility in genital tract infections due to Chlamydia psittaci transmitted through contaminated semen. J Infect Dis 138, 95–98. https://doi.org/10.1093/infdis/138.1.95
[31] Kemmerling, K., Müller, U., Mielenz, M., & Sauerwein, H. (2009). Chlamydophila species in dairy farms: polymerase chain reaction prevalence, disease association, and risk factors identified in a cross-sectional study in western Germany. Journal of dairy science, 92(9), 4347-4354. https://doi.org/10.3168/jds.2009-2051